



Horizon Project

2016 NMC Technology Outlook

International Schools in Asia

A Horizon Project Regional Report



2016 NMC Technology Outlook for International Schools in Asia

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2016 NMC Technology Outlook for International Schools in Asia A Horizon Project Regional Report

is a collaboration between

The New Media Consortium, 21st Century Learning International, and NIST
International School

With the support of Canadian International School of Hong Kong, Chinese International School of
Hong Kong, Eduro Learning, Renaissance College Hong Kong, Shekou International School,
United World College of South East Asia, and International Schools Services (ISS)

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Executive Summary

The *2016 NMC Technology Outlook for International Schools in Asia: A Horizon Project Regional Report* reflects a collaborative research effort between the New Media Consortium (NMC); NIST International School; 21st Century Learning International; Canadian International School of Hong Kong; Chinese International School of Hong Kong; Eduro Learning; International Schools Services (ISS); Renaissance College, Hong Kong; Shekou International School; and United World College of South East Asia to inform school leaders and decision-makers about important developments in technologies supporting teaching, learning, and creative inquiry in schools across the region.

All of the research underpinning the report makes use of the NMC's Delphi-based process for bringing groups of experts to a consensus viewpoint, in this case around the impact of emerging technologies on teaching, learning, or creative inquiry in international schools in Asia over the next five years. The same process underlies the well-known *NMC Horizon Report* series, which is the most visible product of an on-going research effort begun 14 years ago to systematically identify and describe emerging technologies likely to have a large impact on education around the globe.

The *2016 NMC Technology Outlook for International Schools in Asia* was produced to explore important developments in technology and forecast their potential impact expressly in an Asian context. In the effort that took place from September through December 2015, a carefully selected panel of experts was asked to consider hundreds of relevant articles, news, blog posts, research, and project examples as part of the preparation that ultimately pinpointed the most notable technology topics, trends, and challenges for international schools in Asia over the next five years.

Known as the 2016 Horizon Project ISA Expert Panel, that group of thought leaders consists of knowledgeable individuals, all highly regarded in their fields. Collectively the panel represents a range of diverse perspectives across international schools in Asia. The project has been conducted under an open data philosophy, and all the interim projects, secondary research, discussions, and ranking instrumentation can be viewed at isasia.wiki.nmc.org. The precise research methodology employed in producing the report is detailed in a special section found at the end of this report.

The expert panel identified nine key trends, nine significant challenges, and twelve important developments in educational technology. Each of the twelve developments in educational technology are profiled on a single page that describes and defines the technology and are ranked as very important for international schools in Asia over the next year, two to three years, and four to five years.

Every page opens with a carefully crafted definition of the highlighted technology, outlines its educational relevance, points to several real-life examples of its current use, and ends with a short list of additional readings for those who wish to learn more. Preceding those discussions are sections that detail the expert panel's top ranked trends and challenges, and illuminate why they are seen as highly influential factors in the adoption of technology in international schools in Asia over the next five years.

The three key sections of this report constitute a reference and straightforward technology-planning guide for teachers, school leaders, administrators, policymakers, and technologists. It is our hope that this research will help to inform the choices that institutions are making about technology to improve, support, or extend teaching, learning, and creative inquiry in Asian international schools. Educators and administrators worldwide look to the NMC Horizon Project and both its global and regional reports as key strategic technology planning references, and it is for that purpose that the *2016 NMC Technology Outlook for International Schools in Asia* is presented.

Introduction

The NMC Horizon Project and the 2016 Horizon Project International Schools in Asia (ISA) Expert Panel recognise that technology adoption in primary and secondary education is accelerated by trends in policy, leadership, and practice. Therefore, key trends frame the discussion of technology use in international schools. Similarly, a number of challenges are impeding the proliferation of digital tools, and the panel identified a set of significant challenges that reflects the current obstacles facing international schools in Asia over the next five years. The top three trends and challenges are included in the related tables in this summary, and are organised by categories described in the next sections of this report.

As Table 1 below illustrates, the choices of the 2016 ISA experts overlap in interesting ways with those who contributed to the *NMC Horizon Report > 2015 K-12 Edition*, which looked at technology uptake from a global perspective, and the *2014 Technology Outlook for International Schools in Asia*, which provides perspective from the expert panellists in the previous edition of this report, published in 2014 — altogether a group of 217 acknowledged experts.

Table 1: Top-Ranked Trends Across Three NMC Horizon Research Projects

NMC Horizon Report 2015 K-12 Edition	2016 Technology Outlook International Schools in Asia	2014 Technology Outlook International Schools in Asia
Long-Term Impact Trend		
Rethinking How Schools Work	Rise of New Forms of Interdisciplinary Studies	Digital Delivery is Increasingly the Norm
Mid-Term Impact Trend		
Shift from Students as Consumers to Students as Creators	Rethinking How Schools Work	Shift from Students as Consumers to Students as Creators
Short-Term Impact Trend		
Increasing Use of Blended Learning	Shift from Students as Consumers to Students as Creators	Rethinking How Schools Work

One of the 2016 ISA panel's highest ranked trends overlap with the 2015 global panel's selections in a key area — the shift from students as consumers to students as creators. Since its appearance in the 2014 edition of this report, the trend has morphed into a short-term impact trend, which is supported by the confluence of the rising number of makerspaces in schools throughout the world, as well as the implementation of deeper learning strategies such as project-based learning. This new paradigm is embodied by AMPed, a teaching method pioneered by teachers from international schools in Asia, which emphasises student-driven learning through the production of physical and digital products.¹

Also ranked highly by all panels was rethinking how schools work, a mid-term impact trend that is expected to transform learning spaces and school days throughout international schools in Asia. Emerging teaching strategies are inspiring the renovation of classrooms in order to foster more group interaction and teamwork. The Level 5 project at Shekou International Schools, for example, has converted a floor level of offices into one flexible space, designed to be open, agile, and modular. With moveable chairs, couches, desks, and storage units, learning that happens in the classroom is more fluid, adapting to the learning style of any given activity.²

Unique to the 2016 ISA panel was their determination that the rise of new forms of interdisciplinary studies will have a long-term impact on international schools in Asia, and this has been in effect for some time now. As schools in the region transform to accommodate innovative pedagogies and flexible learning configurations, the way that curricula are constructed will change, too. Students are increasingly encouraged to show knowledge in creative and practical ways. At the NIST Makerspace, children have the chance to spend part of their lunch hour working on robotics, wearable technology, and programming projects as they are guided to follow the “think-make-improve” process.³

Horizon Project panels in general have agreed that trends like these are clear drivers of technology adoption; the 2016 ISA panel especially saw such a linkage. At the same time, these panels of experts also agree that technology adoption is often hindered by both local and systemic challenges, which are grounded in everyday realities that make it difficult to learn about, much less adopt, new tools and approaches.

Table 2: Top-Ranked Challenges Across Three NMC Horizon Research Projects

NMC Horizon Report 2015 K-12 Edition	2016 Technology Outlook International Schools in Asia	2014 Technology Outlook International Schools in Asia
Solvable Challenge		
Creating Authentic Learning Opportunities	Balancing Our Connected and Unconnected Lives	Balancing our Connected and Unconnected Lives
Difficult Challenge		
Personalising Learning	Scaling Teaching Innovations	Personalising Learning
Wicked Challenge		
Scaling Teaching Innovations	Challenging Perceptions of Success	Scaling Teaching Innovations

As noted in Table 2, above, all three panels agreed that scaling teaching innovations is a pressing issue for schools. Educators often lack the institutional and moral support to help them extend their practices beyond their own classrooms, and widespread aversion to change hinders large-scale innovation. The key to solving this challenge is finding ways to evaluate and promote the most effective pedagogies throughout entire schools, municipalities, and nations. To make progress on this difficult challenge, education leaders in the international schools believe that it is necessary to raise awareness about innovative practice and tailor these messages carefully for specific audiences.

Both the 2014 and 2016 ISA panels were also in consensus that the issue of balancing our connected and unconnected lives is a problem schools face today as students become more attached to their devices. Recent reports have shown that children and teenagers spend anywhere from six to nine hours daily with media technology.^{4,5} Considered a solvable challenge by the 2016 ISA panel, many teachers consider this a concern that touches on topics like digital footprint, healthy work-life mix, and attitudes about social media. Possible solutions may promote the mindful use of technology and teach students to recognise the importance of a balanced tech-infused lifestyle.

Among the problems that are complex to define, much less solve, the wicked challenge ranked highest by the 2016 ISA panel is specific to the international schools arena — challenging perceptions of success. As major graduate recruiters are changing their requirements to de-emphasise college degrees, more international school leaders are questioning whether entry into

a leading university should be the measure of success. While vocational education and training remains an alternative, the global stigma against technical schools is keeping students and their parents invested in pursuing traditional routes.⁶ This issue is generating conversations about what kinds of experiences students should have before they embark on their post-graduation adventures.

Fuelled by the key trends and impeded by the significant challenges selected by the panel, the 12 important developments in educational technology presented in the body of this report reflect our experts' opinions as to which of the nearly 50 technologies considered will be most important to international schools over the five years following the publication of the report. All three of these projects' expert panels strongly agree that makerspaces, along with cloud computing, will likely tip into mainstream use within the next year.

Table 3: Comparison of “Final 12” Topics Across Three NMC Horizon Research Projects

NMC Horizon Report 2015 K-12 Edition	2016 Technology Outlook International Schools in Asia	2014 Technology Outlook International Schools in Asia
Time-to-Adoption Horizon: One Year or Less		
Bring Your Own Device Cloud Computing Makerspaces Mobile Learning	3D Printing Cloud Computing Makerspaces Social Networks	Cloud Computing Games and Gamification Makerspaces Mobile Apps
Time-to-Adoption Horizon: Two to Three Years		
3D Printing Adaptive Learning Technologies Information Visualisation Learning Analytics	Augmented Reality Bring Your Own Device Drones Wearable Technology	3D Printing Learning Analytics Massive Open Online Courses Personal Learning Environments
Time-to-Adoption Horizon: Four to Five Years		
Digital Badges Drones Visual Data Analysis Wearable Technology	Affective Computing Flexible Displays Telepresence Virtual Reality	The Internet of Things Virtual and Remote Laboratories Virtual Reality Wearable Technology

Based on the selections of the 2016 ISA panel, there is a sense that international schools in Asia are leading the way in the adoption of new technologies for teaching and learning. 3D printing, which was identified as a mid-term technology in 2014, was pushed forward into the near-term horizon this year, and this shift is evident in numerous schools throughout the region. Similarly, two technologies that were described as far-term developments by the global panel — wearable technology and drones — were identified as mid-term technologies by the 2016 ISA panel. Drones, especially, generated considerable interest due to their potential applications for STEM instruction, digital storytelling, and virtual campus tours. Some physical education instructors in international schools in Asia are already adopting wearable technology; GoPros and wristbands are helping them monitor students' activity and quantify their movement.⁷

The 2016 ISA experts have also diverged from other panels with their perspective for the far-term horizon. Affective computing, flexible displays, and telepresence were identified as technologies that show promise for international schools in Asia. Currently, telepresence robots such as Kubi and VGo are being used in higher education to help remote instructors and students interact with their on-site counterparts,⁸ and the 2016 ISA panel anticipates their entry into schools in the next four to five years. Development behind flexible screens has led to E Ink displays, which are increasingly embedded on wearable technologies such as smart watches and smart jewellery.

Key Trends Accelerating Technology Adoption

The technology developments featured in the NMC Horizon Project are embedded within a contemporary context that reflects the realities of the time, both in the sphere of education and in the world at large. To assure this perspective, each panel member identifies and ranks key trends that are currently affecting teaching, learning, and creative inquiry in international schools in Asia, and uses these as a lens for the work of predicting the uptake of emerging technologies. These nine trends, which the panel agreed are very likely to drive technology planning and decision-making over the next five years, are sorted into three categories: long-term impact trends that have been important for some time and will continue to be pervasive in schools for five or more years, and mid- and short-term impact trends that have surfaced more recently and whose impact on schools may be briefer.

Long-Term Impact Trends

Driving Ed Tech adoption in international schools in Asia for five or more years

Proliferation of Open Education Resources. Open educational resources (OER) are “teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use and repurposing by others.”⁹ Often mistaken to simply mean “free of charge,” advocates of openness have worked towards a common vision that defines it more broadly — not just free in economic terms, but also in terms of ownership and usage rights. Recent case studies carried out by the Asian Development Bank found that although the adoption of OER is not yet widespread, education institutions anticipate long-term cost savings and speedier course developments as a result of OER uptake.¹⁰

Rise of New Forms of Interdisciplinary Studies. According to Sage Publications, interdisciplinary studies refer to educational activities that blend two or more disciplines, such as engineering and art.¹¹ More K-12 schools are finding meaningful ways for students to experience the intersections between disciplines, engaging in activities that combine critical thinking, imagination, and practical application. Makerspaces, in particular, are becoming more common among international schools in Asia as places where children can work on demonstrating their knowledge through robotics, wearable technology, and programming projects.

Shift to Deep Learning Approaches. There is a growing emphasis in the classroom on deep learning approaches, defined as the delivery of rich core content to students in innovative ways that allow them to learn and then apply what they have learned.¹² Project-based learning, challenge-based learning, and similar student-centred methods are becoming more pervasive throughout Asia. A group of international school educators has founded one such active learning approach called AMPed, which requires students to dig deep and pursue their learning with purpose. Student projects include a wide range of experimental, aerial, and craft-based activities.¹³

Mid-Term Impact Trends

Driving Ed Tech adoption in international schools in Asia for the next three to five years

Advancing Cultures of Change and Innovation. In order to breed innovation and adapt to economic needs, schools must be structured in ways that spur creativity and entrepreneurial thinking. Educators are working to develop new approaches and programmes that stimulate top-down change and can be implemented across a broad range of school settings. Technology is a catalyst for promoting a school culture of innovation in a widespread, cost-

effective manner. At NIST International School, students are engaging in social entrepreneurship programmes that lead them to explore business and not-for-profit ideas.¹⁴

Increasing Use of Hybrid/Blended Learning Designs. Perceptions of online learning are becoming more favourable as international schools in Asia experience the benefits of blended learning models. Schools that embrace hybrid learning are finding that online learning environments offer different, but complementary functions to classroom learning and free up time for face-to-face interactions. Educators from international schools in Asia are learning to teach digital citizenship using an online resource called EDTech Framework for Schools that helps them create individualised learning paths for students.¹⁵ Using mini-lessons and content that can be accessed online, teachers can assess students' abilities, which informs their instructional strategy in the classroom.

Rethinking How Schools Work. There is a focused movement to reinvent the traditional classroom paradigm and rearrange the entire school experience. Methods such as project- and challenge-based learning call for school structures that enable students to move from one learning activity to another more seamlessly and remove the limitations of the traditional bell schedule. Many international schools in Asia have used the International School of Beijing Futures Academy as a model for a school that is designed around experiential learning. All four subjects at ISB are integrated, teachers act as facilitators who provide resources, and learning spaces are open and flexible.¹⁶

Short-Term Impact Trends

Driving Ed Tech adoption in international schools in Asia for the next one to two years

Growth Focus on Measuring Learning. There is an increasing interest in using new sources of data for personalising the learning experience, for on-going formative assessment of learning, and for performance measurement. The goal is to build better pedagogies, empower students to take an active part in their learning, target at-risk student populations, and assess factors affecting completion and student success. The International Research Collaborative Technology Use and Belief Study is one such initiative that unites educational researchers, data scientists, and K-12 school leaders to evaluate the impact of educational technology on teaching and learning. Targeting international schools, the project seeks to produce data that can inform schools' decision-making for technology investments.¹⁷

Redesigning Learning Spaces. As international schools in Asia continue to move away from traditional lecture-based programming to more hands-on scenarios, classrooms will start to resemble real-world work and social environments that facilitate organic interactions and cross-disciplinary problem-solving. Schools in southeast Asia such as Shekou International School have furnished their classrooms with rolling couches and stools, as well as trolleys that carry AV equipment, allowing any surface to become a projection space. Because nearly all furnishings are moveable, the students and instructors are free to manipulate the space to accommodate different learning experiences.¹⁸

Shift from Students as Consumers to Students as Creators. A shift is taking place in schools all over the world as students across a wide variety of disciplines are learning by making and creating rather than from the simple consumption of content. Creativity, as illustrated by the growth of user-generated videos, maker communities, and crowd-funded projects in the past couple years, is increasingly the means for active, hands-on learning. At NIST International School, learners are encouraged to produce video content for NIST TV, a platform with various channels for elementary students. Each 'channel' is operated, scripted, created, edited, acted, directed, filmed, and produced by elementary students for other students to learn from.¹⁹

Significant Challenges Impeding Technology Adoption

Along with the trends discussed in the preceding section, the expert panel noted a number of significant challenges faced in international schools in Asia that are impeding the uptake of emerging technologies. Because not all challenges are of the same scope, the discussions here are sorted into three categories defined by the nature of the challenge. The NMC Horizon Project defines solvable challenges as those that we both understand and know how to solve; difficult challenges are ones that are more or less well understood, but for which solutions remain elusive. Wicked challenges, the most difficult, are categorised as complex to even define, and thus require additional data and insights before solutions will be possible.

Solvable Challenges

Those which we both understand and know how to solve

Balancing Our Connected and Unconnected Lives. With the abundance of content, technologies, and online social networks, learning institutions need to lead the way in modelling the balance between connected and unconnected life. Promoting the mindful use of technology means making students aware of their digital footprint and encouraging them to pursue sensorial experiences that are crucial to developing character and integrity. Finding a balance and guiding learners to personal success should be society's compromise with new generations of students.

Creating Authentic Learning Opportunities. Authentic learning is still all too uncommon in schools. Pedagogies based on authentic learning immerse students in real world experiences and put them in touch with the outside world. The annual Week Without Walls event at Shekou International School encourages students to go off campus to learn through collaboration and service with the greater community.²⁰ The school has also established a partnership with Tencent, an entertainment company based in China, to provide short-term internships for students that include designing characters for video games and producing audio for an animated feature.

Improving Digital Literacy. Because the Internet, mobile devices, and other technologies are now pervasive in education, the traditional view of literacy as the ability to read and write has expanded to encompass understanding digital tools and information. Lack of consensus on what comprises digital literacy is impeding many international schools in Asia from formulating adequate policies and programmes to address this challenge. Compounding this issue is the notion that digital literacy encompasses skills that differ for educators and learners, as teaching with technology is inherently different from learning with it. Supporting digital literacy will require policies that both address digital fluency training in pre- and in-service teachers, along with the students they teach.

Difficult Challenges

Those we understand but for which solutions are elusive

Aligning Key Stakeholders Toward Innovation. As with any major change or disruption to education, parents play a huge role in the success of the implementation of innovative practice. This is especially true in the international school arena, where parent voice is highly influential. This being the case, it is imperative that parents are educated to help them understand why changes in curriculum may occur. In order to garner strong support from parents, there needs to be specific orientation and awareness around passion-driven, student-centred learning activities. Educational leaders at NIST International School have started

addressing this problem through the creation of a website where parents can learn about digital citizenship and the technological tools their children are using in the classroom.²¹

Scaling Teaching Innovations. International schools in Asia are not yet adept at moving teaching innovations into mainstream practice. Innovation springs from the freedom to connect ideas in new ways, yet current administration structures do not always reward improvements in teaching and learning, nor help to spread those successful practices across schools and districts. A pervasive aversion to change limits the diffusion of new ideas, and too often discourages experimentation that could improve the quality of instruction. ISA leaders believe that implementing large-scale innovation requires carefully designed communications about new practices, tailored to fit relevant audiences.

Teaching Complex Thinking. It is essential for young people both to understand the networked world in which they are growing up and also — through computational thinking — to understand the difference between human and artificial intelligence, learn how to use abstraction and decomposition when tackling complex tasks, and deploy heuristic reasoning to complex problems. In the international schools community, there has been a strong emphasis on promoting programming and coding as the gateways to complex thinking. At NIST International School, coding has been introduced in the Primary Years Programme to begin reinforcing logical and computational thinking.²²

Wicked Challenges

Those that are complex to even define, much less address

Challenging Perceptions of Success. Recent changes to the hiring policies of one of the UK's biggest graduate recruiters have raised global awareness about the devaluation of the college degree.²³ Yet, schools and parents still perceive college entry as the ultimate endgame for most students. There is a need to transform the perception of what success looks like in schools if educators aim to meet the needs of all learners. Education leaders in international schools in Asia believe that the current standard is stifling innovation, creativity, and progress toward forward-thinking models of schooling. At UWCSEA, university advising counsellors have prioritised this issue, helping students explore future options through access to personality tests, alumni mentors, and industry partners.²⁴

Competing Models of Education. New models of education are bringing unprecedented competition to schools, especially for students whose needs are not being well served by the current system. Charter, for-profit, and online schools have particularly gained traction in the United States, the United Kingdom, and Scandinavia. For school leaders and policymakers, the challenge is to meet such competition head on, offering high-quality alternatives to students who need them. As new platforms emerge, there is a growing need to frankly evaluate models and determine how to best support collaboration, interaction, deep learning experiences, and assessment at scale.

Keeping Education Relevant. As free educational content grows in abundance on the Internet, there may come a time when formal schooling becomes unnecessary. There are, however, valuable skills and attitudes that can only be acquired in formal school settings. Soft skills, such as face-to-face communication and collaboration, are essential for solving problems in a diverse and interconnected world. Similarly, work ethic and the ability to persevere through even the toughest challenges, both social and academic, are reinforced in formal education environments. The idea is to rethink the value of education as a means of reinforcing attitudes and skills learners will need to apply their knowledge, work effectively in teams, and persist in achieving their goals.

Time-to-Adoption: One Year or Less

3D Printing

Known in industrial circles as rapid prototyping, 3D printing refers to technologies that construct physical objects from three-dimensional (3D) digital content such as 3D modelling software, computer-aided design (CAD) tools, computer-aided tomography (CAT), and X-ray crystallography. A 3D printer builds a tangible model or prototype from the electronic file, one layer at a time, through an extrusion-like process using plastics and other flexible materials, or an inkjet-like process to spray a bonding agent onto a very thin layer of fixable powder. The deposits created by the machine can be applied very accurately to build an object from the bottom up, with resolutions that are more than sufficient to express precise detail. The process can even accommodate moving parts within the object. Using different materials and bonding agents, colour can be applied, and parts can be rendered in plastic, resin, metal, tissue, and even food. This technology is commonly used in manufacturing to build prototypes of almost any object (scaled to fit the printer) that can be conveyed in three dimensions. According to Gartner, global 3D printer shipments are expected to double every year between 2016 and 2019, with schools and universities as the primary market drivers.²⁵

Relevance for Teaching, Learning, or Creative Inquiry

- 3D printing allows for authentic exploration of objects that may not be readily available to schools, including animal anatomies, ancient artefacts, and toxic materials.
- 3D printing shows promise as a rapid prototyping and production tool, providing students with the ability to touch, hold, and even take home a concrete model of their idea.
- The exploration of 3D printing, from design to production, as well as demonstrations and participatory access, opens up new possibilities for learning activities.

3D Printing in Practice

- Fourth graders at Shekou International School used 3D printers to produce jewellery designs and displayed them at a local art exhibition: go.nmc.org/clip.
- Secondary classes at Regents International School Pattaya will feature the use of the Generation 5 MakerBot to boost efficiency and creativity for their 3D designs: go.nmc.org/regents.
- With the recent introduction of the Ultimaker 2 3D printer, students in the Architecture Club at the International School of Asia, Karuizawa, are now able to test multiple prototypes more rapidly and efficiently until satisfied with a final product: go.nmc.org/kar.

For Further Reading

3D Printing Can Transform Education Sector in India

go.nmc.org/3D

(Jasmine Kohli, *Dataquest*, 5 June 2015.) Primary schools in India are beginning to realise the undoubted benefits 3D printing brings into the classroom. For example, Good Shepherd International School, Ooty, introduced 3D printing into the curriculum, as it requires the student to interact with the product throughout the entire process, thus fostering higher-level thinking than previous methods.

Educate 3D Contest: Materialise Extends New Challenge to Southeast Asian Teachers & Students

go.nmc.org/educate3D

(Bridget B. Millsaps, *3Dprint.com*, 16 June 2015.) During Summer 2015, the Ideas Worth Making contest expanded its 3D printing competition into Southeast Asia, where primary and secondary schools were invited to submit an original 3D product.

Time-to-Adoption: One Year or Less

Cloud Computing

Cloud computing refers to expandable, on-demand services and tools that are served to the user via the Internet from specialised data centres and consume almost no local processing or storage resources. Cloud computing resources support collaboration, file storage, virtualisation, and access to computing cycles, and the number of available applications that rely on cloud technologies has grown to the point that few education institutions do not make some use of the cloud, whether as a matter of policy or not. Over the past few years, cloud computing has been firmly established as an efficient way for businesses to protect data, develop applications, deliver software and online platforms, and collaborate. The latest findings from Research and Markets estimate that cloud computing in education will grow from \$5.8 billion in 2015 to \$15.02 billion by 2020, and the adoption of cloud services by schools and universities in the Asia Pacific region is expected to expand the most rapidly in that time.²⁶

Relevance for Teaching, Learning, or Creative Inquiry

- At the school level, flexible options for computing, bandwidth, and storage offered by providers can be reconfigured on the fly, and in most cases are considerably cheaper than the capital and operational costs of dedicated data centres.
- At the user level, secure cloud resources are less expensive than licensed products, and they increase access to storage, tools, media, and educational materials for learners.
- Cloud-based services support collaborative learning competencies, encouraging students to work simultaneously on a document in the same room or across continents.

Cloud Computing in Practice

- At Chatsworth International School in Singapore, students create online courses to teach each other, display their learning on websites, and collaborate on writing tasks using Google Docs: go.nmc.org/cloudcis.
- Chinese language instructors at American International School of Guangzhou implement interactive quizzes and automatic grading technology using cloud-based tools that are part of Microsoft Office 365: go.nmc.org/aisg.
- The Taejon Christian International School in South Korea relies on cloud tools including Google Drive and Adobe Creative Cloud to support productivity and creativity: go.nmc.org/tcis.
- SOLE Central has developed a School in the Cloud platform to allow international schools to create learning environments that enable students to learn collaboratively by leveraging an Internet connection and cloud resources: go.nmc.org/sole.

For Further Reading

Can Cloud Deliver on the Promise of an Integrated Curriculum?

go.nmc.org/stemcloud

(Julie Smith, *EdTech Magazine*, 30 March 2015) As technologies become more affordable, school districts are increasingly using cloud computing for storage, collaboration, and productivity needs. Scalable software has the potential to expand STEM learning opportunities.

The Cloud in K-12

go.nmc.org/learncloud

(Allie Gross, *Education Dive*, 3 March 2015) This article provides insights for educators to better understand cloud computing by addressing benefits, deployment processes, and security concerns.

Time-to-Adoption: One Year or Less

Makerspaces

The driving force behind makerspaces is rooted in the maker movement, a following of artists, tech enthusiasts, engineers, builders, tinkerers, and anyone else who has a passion for making things. The formation of the movement stems from the success of the Maker Faire, a gathering that launched in 2006, and has since propagated itself into numerous community-driven events all over the world. The turn of the 21st century has signalled a shift in what types of skillsets have real, applicable value in a rapidly advancing world. In this landscape, creativity, design, and engineering are making their way to the forefront of educational considerations as tools such as 3D printers, robotics, and 3D modelling web-based applications become accessible to more people. This development is expected to gain more traction with the recent debut of MakerSpace, a new online social network built for the Maker Faire community that allows users to share projects and follow each others' progress.²⁷

Relevance for Teaching, Learning, or Creative Inquiry

- Makerspaces equipped with technologies and construction supplies are all-purpose workshops that represent the power of creation in both the virtual and physical world.
- Makerspaces that can be accessed outside of scheduled classes provide a place for teachers and students to pursue making activities on their own or participate in extracurricular camps that promote design skills with a variety of tools.
- Pedagogies such as inquiry-based learning and design thinking, which encourage planning, construction, and delivery to foster deeper engagement from students, can be carried out in makerspaces.

Makerspaces in Practice

- Concordia International School Shanghai hosts the annual Jinqiao Maker Faire, showcasing diverse projects such as furniture, rockets, and underwater vehicles created in the school's makerspace: go.nmc.org/jmf.
- Level 5, a new space for creativity and design established by International Schools Services, aims to unleash students' creative potential and provide opportunities for teachers to experiment with emerging pedagogies: go.nmc.org/lev5.
- Middle school students serve as coaches in the makerspace at NIST International School in Bangkok, assisting others with stop-motion animation, 3D printing, and more: go.nmc.org/nistmake.

For Further Reading

How to Ensure that Making Leads to Learning

go.nmc.org/cogmake

(Annie Murphy Paul, *School Library Journal*, 12 May 2015). Cognitive research theories are explored and applied to maker activities. Educators can maximise students' learning potential through "unbundling" learning and creating, encouraging productive failure, and withholding solutions until students have brainstormed creative workarounds.

Starting a School Makerspace from Scratch

go.nmc.org/newspace

(Colleen Graves, *Edutopia*, 16 July 2015). This article presents resources for educators wanting to establish a makerspace, with an emphasis on integration into the greater global maker community. Guidance for outfitting a makerspace and tips for incorporating creative inquiry and experimentation are also included.

Time-to-Adoption: One Year or Less

Social Networks

Today's web users are prolific creators of content, and they upload photographs, audio, and video to cloud-based social networks such as Facebook, Pinterest, Twitter, YouTube, Flickr, and many others by the billions. While the initial emphasis of social networks was placed on producing and uploading media to these popular sharing sites, as the notion of social media has evolved it has ultimately become more about the conversations started and relationships formed via this media. For educational institutions, social media enables two-way dialogues between students, prospective students, educators, and the institution that are less formal than with other media. Emerging mobile-based messaging apps such as WeChat, WhatsApp, and QQ are making social networks and continuous group interactions even more ubiquitous. As social media comprises a bigger part of everyday life, more school leaders and educators are considering the educational benefits of using global platforms to teach students about strategic communication.

Relevance for Teaching, Learning, or Creative Inquiry

- Engagement in social networks either as producers of content, consumers, or aggregators of user-generated content allows teachers to more deeply connect with each other.
- Social networks enable students to create powerful personal learning networks to direct and focus their own learning.
- Video platforms including YouTube and Vimeo enable educators to upload and share instructional videos that students can watch anywhere. Similarly, Google Hangouts allow them to connect with students outside of the classroom.

Social Networks in Practice

- At Seisen International School in Tokyo, teachers are integrating Twitter into their classrooms to teach learners how to share meaningful messages on a global platform: go.nmc.org/tweetisa.
- Kindergarten teachers at Beijing BISS International School use WeChat to participate in authentic, real-time exchanges about their experiences and concerns using technology for teaching: go.nmc.org/bisschat.
- Started by educational leaders from the Shanghai international schools community, Learning2 is a conference that leverages social networks to advance their mission of innovating social learning globally: go.nmc.org/learn.

For Further Reading

Making the Case for Social Media in Schools

go.nmc.org/casesoc

(Jim Asher, *Edutopia*, 7 August 2015.) A middle school principal describes how social networks have become a fundamental part of administrative operations and classroom teaching in his district. Teachers are using social media to aid in their professional development, showcase student learning through photo and video, and connect with experts to have real-time dialogues.

Role of Social Media in School Leadership

go.nmc.org/isasocial

(Michael Boll, 21st Century Learning International, 16 October 2015.) This interview with leaders in the international schools community describes how social networks can be leveraged to facilitate relationship-building, reinforce school culture and ethos, and bolster foreign language skills.

Time-to-Adoption: Two to Three Years

Augmented Reality

Augmented reality (AR), a capability that has been around for decades, has shifted from what was once seen as a gimmick to a tool with tremendous potential. The layering of information over 3D space produces a new experience of the world, sometimes referred to as “blended reality,” and is fuelling the broader migration of computing from the desktop to the mobile device, bringing with it new expectations regarding access to information and new opportunities for learning. While the most prevalent uses of augmented reality so far have been in the consumer sector (for marketing, social engagement, amusement, or location-based information), new uses seem to emerge almost daily. A key characteristic of augmented reality is its ability to respond to user input, which confers significant potential for learning and assessment; with it, learners can construct new understanding based on interactions with virtual objects that bring underlying data to life. Dynamic processes, extensive datasets, and objects too large or too small to be manipulated can be brought into a learner’s personal space in a form easy to understand and work with.

Relevance for Teaching, Learning, or Creative Inquiry

- Augmented reality constructs provide contextual, in situ learning experiences that foster exploration of real world data in virtual surroundings and simulations.
- Games that are based in the real world and augmented with networked data give educators powerful new ways to show relationships and connections in computer science.
- Students doing outdoor fieldwork can access AR applications to overlay maps and information about their surroundings, or to enter field observations and data that are automatically geocoded as the records are created.

Augmented Reality in Practice

- The Junior School at Dulwich College Suzhou has deployed augmented reality technology to amplify the learning potential of short films and podcasts created by its students: go.nmc.org/arproj.
- Students at Concordia International School Shanghai use Aurasma, an augmented reality app, to layer digital animations and videos in their classrooms, deepening engagement with educational content: go.nmc.org/arclass.
- Year Five students at the British International School Abu Dhabi have created learning displays with interactive ‘auras’ using the Aurasma app, enabling viewers to experience an enhanced blend of digital and physical objects: go.nmc.org/aura5.

For Further Reading

Audio Review # 94, Telestory Scaffolds Video Story Telling
go.nmc.org/artele

(Michael Boll, Concordia International School Shanghai EdTech Podcast, 7 April 2015). Students at Concordia International School Shanghai review the educational possibilities of Telestory, a free mobile app that provides an augmented reality video camera to guide users through the creation of video stories.

How to Transform Your Classroom With Augmented Reality
go.nmc.org/augedu

(Patricia Brown, *EdSurge*, 2 November 2015). By blending the physical and virtual environment, augmented reality technologies are poised to transform the delivery of knowledge. Classroom-ready apps allow the creation of rich learning environments, enabling students to construct broader understandings as underlying data comes to life.

Time-to-Adoption: Two to Three Years

Bring Your Own Device

BYOD, also referred to as BYOT (Bring Your Own Technology), refers to the practice of people bringing their own laptops, tablets, smartphones, or other mobile devices with them to the learning or work environment. Intel coined the term in 2009 when the company observed that an increasing number of its employees were using their own devices and connecting them to the corporate network.²⁸ In schools, the BYOD movement addresses the same reality; many students are entering the classroom with their own devices, which they use to connect to the school's network. While BYOD policies have been shown to reduce overall technology spending, they are gaining traction more so because they reflect the contemporary lifestyle and way of working. Although administrators and educators have cited IT security concerns, technology gap issues, and platform neutrality as challenges to the uptake of this technology, a growing number of models in practice are paving the way for BYOD to enter the mainstream. This technology development is especially pertinent to international schools in Southeast Asian countries, such as the Philippines, where governments are more encouraging of the "mobile first" mentality.²⁹

Relevance for Teaching, Learning, or Creative Inquiry

- Because BYOD allows students access to the same devices at school and at home, it can extend learning opportunities to times and places outside of the classroom.
- BYOD policies allow students and instructors to work with technology with which they are already comfortable and familiar.
- BYOD programmes eliminate the support and other demands placed on schools that accompany paying for and maintaining institution-provided devices.

BYOD in Practice

- At Boracay International School in the Philippines an important element of the school's BYOD policy is allowing the students choice over their devices, enabling them to match features such as size and operating system to their learning needs: go.nmc.org/boracay.
- Ghiyasuddin International School in the Maldives has launched a BYOD pilot, allowing students to access online resources, and leveraging digital learning and assessment tools to provide them with instant feedback: go.nmc.org/gis.
- Nibras International School in Dubai invested in a wireless network system that can support up to 500 devices at any one time, so that students and teachers can use their devices for sharing reference material and collaborating on projects and assignments: go.nmc.org/nib.

For Further Reading

5 Proven Benefits of Implementing BYOD in Schools

go.nmc.org/5ben

(Sandip Kar, *EdTech Review*, 10 August 2015.) The author explores how BYOD is driving positive changes in K-12 education. When using their own devices, for example, students are able to drive their own learning experiences, access mobile apps for further engagement, and organise their work in a manner that is most effective for them.

The Brutal Authenticity of BYOD

go.nmc.org/auth

(Terry Heick, *TeachThought*, 6 February 2015.) A BYOD policy can empower learners by providing them pathways to solve problems, access resources, and create their own workflow patterns. It creates a classroom culture that gives students the opportunity to connect their learning in the classroom with their personal lives.

Time-to-Adoption: Two to Three Years

Drones

Drones are unmanned aerial vehicles that are controlled autonomously by computers or pilots with remote controls. They were innovated in the early 1900s for military personnel training and typically leveraged in operations considered too dangerous or time-consuming for humans. Still most commonly used for military purposes, drones have been deployed for a wide range of tasks, such as policing and community surveillance, filmmaking, and the surveying of agriculture and crops. In the past century, drone technology has advanced users' abilities to extensively view objects and landscapes below, as well as to detect changes in environmental conditions. The world's leading commercial drone manufacturer, DJI, recently launched a Software Development Kit that allows users to build custom apps for a broader variety of purposes. While there are not yet concrete applications for teaching and learning, continuous progress of drones in the consumer sector makes them compelling to watch closely over the next few years.³⁰

Relevance for Teaching, Learning, or Creative Inquiry

- Drones could be used for virtual campus tours made by students or to facilitate study trips that provide a real-time, primary source of information for students to 'see' into hazardous places.
- Drones offer brand new forms of digital storytelling and filming and opportunities for students to learn innovative camera techniques with moving perspectives and different angles.
- The technology behind drones have significant implications for STEM instruction, offering opportunities for students to work in teams to design and build drones that could be used for practical purposes.

Drones in Practice

- 3D Robotics (3DR) recently announced the launch of its 3DU educational programme to bring drones to more schools, hoping to empower students to not just use the drones, but to develop their own apps for them using 3DR's DroneKit software development kit: go.nmc.org/3dr.
- The Chinese province of Luoyang has deployed drones to search for and identify the location of radio signals that signify cheating students during the "gaokao" higher education access exam: go.nmc.org/spot.
- Drone study programmes are opening across China to provide students the experience of flying drones and to teach them important regulations, in addition to how drones are built and repaired: go.nmc.org/droneschools.

For Further Reading

7 Ways to Use Drones in the Classroom

go.nmc.org/7ways

(Heather Wolpert-Gawron, *Edutopia*, 12 November 2015.) Integrating drones in K-12 education can be a multidisciplinary pursuit. This article describes potential learning activities spurred by including drones in social studies, language arts, physical education, math, and other subjects.

Apps, Bots, Drones, and 3D Printers: Coming to a School Near You?

go.nmc.org/coming

(Bryson Payne, *opensource.com*, 8 September 2015.) The presence of emerging technologies and devices in schools, most notably drones, is encouraging students to learn vital programming skills. The author believes coding is key to turning students into innovators that contribute new problem-solving services and products.

Time-to-Adoption: Two to Three Years

Wearable Technology

Wearable technology refers to computer-based devices that can be worn by users, taking the form of an accessory such as jewellery, eyewear, or even actual items of clothing such as shoes or a jacket. The benefit of wearable technology is that it can conveniently incorporate tools that track sleep, movement, location, and social media interactions, or, in the case of Oculus Rift and similar gear,³¹ it can enable virtual reality. There are even new classes of devices that are seamlessly integrated with a user's everyday life and movements. In the recent past, Google Glass has been one of the most heavily discussed wearables,³² enabling users to see information about their surroundings displayed in front of them. Smart watches from Apple, Samsung, Sony, and Pebble are already allowing users to check emails and perform other productive tasks through a tiny interface. Fitness trackers such as Jawbone, Fitbit, Garmin, and Misfit have grown more popular with consumers within the last year, making the quantified self movement a part of everyday life. In an educational context, today's wearables have the potential to help learners track their behaviours, determine their aspirations, and set goals to be accomplished.³³

Relevance for Teaching, Learning, or Creative Inquiry

- Effective wearable devices become an extension of the person wearing them, allowing them to comfortably engage in everyday activities, such as checking and responding to emails and other tasks that help teachers and students to stay productive on-the-go.
- Students already spend time in formal classroom settings, gathering data about themselves or research topics they have been assigned. Quantified self-enabled wearables tap into this interest to make the data collection process much easier.
- Wearable devices such as Oculus Rift provide a virtual reality-enhanced experience for users, making simulation activities more realistic and immersive.

Wearable Technology in Practice

- At the Asia Pacific Physical Education Conference, physical educators from the Delia School of Canada organised a workshop to teach educators how to use GoPro cameras to assess student decision-making from a first-person perspective: go.nmc.org/appec.
- High schools in Japan participated in a competition to design their own devices such as fashionable GPS-enabled wristbands that can wirelessly connect to an array of mobile apps: go.nmc.org/dram.
- Shekou International School ensures that their students move 240 minutes a week with MinZ, a workout program that uses strapped-on sensors to monitor the participant's activity and quantifies their movement: go.nmc.org/minz.

For Further Reading

Wearable Technology and Apps Could Yield Leap Forward for PE, Says Charity
go.nmc.org/petech

(Schools of the Future, 9 January 2016.) "Life-logging" devices such as Autographer and Narrative Clip are wearable technology devices that aid in experiential learning activities in which students need to collect information and footage for projects.

Wearable Technology in the Classroom: Google Expeditions
go.nmc.org/wearinclass

(Nicola Slawson, *The Guardian*, 23 June 2015.) Publisher Tancent and gaming technology company Razer have teamed up in China to create a unique gaming experience that rewards physical activity based on tracking steps, calories burned, and hours slept through a wristband. This article describes the benefits of such technology in physical education.

Time-to-Adoption: Four to Five Years

Affective Computing

Affective computing refers to the idea that humans can program machines to recognise, interpret, process, and simulate the range of human emotions.³⁴ This concept revolves around the development of software and hardware that enable computers to attain humanlike understanding through activities such as implementing a video camera to capture facial cues and gestures that work in conjunction with an algorithm that detects and interprets these interactions. Not to be confused with facial recognition technologies associated with security, like those that facilitate secure payment transactions, affective computers recognise emotional and behavioural signals that trigger a reactionary process. In schools, affective computing can reinforce blended learning environments wherein a computerised tutor reacts to facial indications of boredom from a student in an effort to motivate or boost confidence. With researchers at major institutions working on educational applications,^{35,36} and start-up companies exploring other novel uses, growth in this field has deep implications for the future of human and computer interactions.

Relevance for Teaching, Learning, or Creative Inquiry

- Affective computing applications can be integrated into online learning environments to help detect students' emotions and adapt activities and exercises accordingly.
- Computers that can recognise human faces, cues, and gestures can connect with students on an individual level and offer a more personalised learning path.
- When applied to robots, affective computing can help improve emerging teaching practices such as remote instruction through telepresence.

Affective Computing in Practice

- At Annamalai University in India, initial experimentation with an intelligent virtual tutoring system that adapts to students' affective states has generated a positive response from students and furthered development and integration into virtual environments: go.nmc.org/cogtut.
- EmotionsOnto is a generic ontology for describing emotions and their detection and expression systems that can be used to engineer emotion-aware applications such as brain-computer interfaces: go.nmc.org/emotonto.
- Pepper is a robot that leverages cameras, lasers, and infrared technology to detect human faces and emotions. The accompanying software application kit allows users to create applications for the robot: go.nmc.org/pep.

For Further Reading

Affective Computing: How 'Emotional Machines' Are About To Take Over Our Lives
go.nmc.org/emotma

(Madhumita Murgia, *The Telegraph*, 15 January 2016.) This article describes how an MIT startup called Affectiva is testing emotion-sensing technology in a variety of fields, including their collaboration with a Japanese car company on building an in-car emotion sensor that knows when drivers are drowsy or distracted, as well as emotion decoders to aid autistic users.

A Review of Emotion Regulation in Intelligent Tutoring Systems
go.nmc.org/emotreg

(Mehdi Malekzadeh et al., *Journal of Educational Technology & Society*, 18 March 2015.) This article discusses existing studies on the implementation of emotion regulation strategies within intelligent tutoring systems in order to show how digital learning can produce more optimistic emotions and improve learning gains.

Time-to-Adoption: Four to Five Years

Flexible Displays

When organic light-emitting diode displays (OLED) began to enter mass markets in 2004, consumers found that the new screens were lighter, brighter, and more energy efficient. In contrast to traditional glass-based LCD units, these new displays could be manufactured on thin, pliable plastics, prompting the term "flexible displays." The popularity of OLED screens is largely due to their electroluminescence, which makes for more readable displays. LG, Samsung, and Philips, and other major players in the electronics industry are already producing flexible display TVs, and Apple has since patented its own pliable display. In early 2016, LG debuted a prototype for an 18-inch display that could be rolled up like a newspaper.³⁷ As flexible displays gain traction in the consumer market, researchers, inventors, and developers are experimenting with possible applications for teaching and learning. Opportunities offered by flexible OLED screens in education settings are being considered for e-texts, e-readers, and tablets. Additionally, flexible displays can wrap around curved surfaces, allowing for the possibility of scientific and other instruments with built-in instruction manuals.

Relevance for Teaching, Learning, or Creative Inquiry

- Flexible screens can easily be attached to objects or furniture, regardless of their shape, making them far more adaptable and portable than standard computer screens and mobile devices.
- More durable than glass, thin, bendable displays can make mobile devices lighter and more wearable.
- Prototypes for flexible displays in the form of "e-paper" have the potential to revolutionise digital textbooks and e-readers.

Flexible Displays in Practice

- Korean researchers have developed a flexible and transparent skin-like tactile sensor that can give sensing capabilities to wearable devices, robots, and touch panel components for flexible displays: go.nmc.org/asiahapt.
- The LookSee bracelet is a smart wearable that connects to iPhones to display text, photos, and boarding passes on a thin, curved e-ink screen: go.nmc.org/looksee.
- Polyera, a flexible electronics company, has created the Wove, a smartwatch with a touch screen that bends around the wrist. Software developers can apply to receive a prototype before the device hits the market later this year: go.nmc.org/wove.

For Further Reading

New Electronic Paper Could Make Inexpensive Electronic Displays

go.nmc.org/magnet

(Phys.org, 21 April 2015.) Researchers from the University of Tokyo have revamped earlier technology to create "e-paper," a durable and reusable medium to be used in place of traditional pen and paper or larger-scale writing boards. These electromagnetic boards are less expensive than other current tech-enabled boards, placing them within realistic financial reach for some institutions.

Tackling the "Achilles' Heel" of OLED Displays

go.nmc.org/yieldjet

(Rob Matheson, *MIT News*, 12 February 2015.) MIT researchers founded the company Kateeva, which is tackling the problem of high-cost manufacturing for OLEDs. Kateeva's solution is known as YIELDjet FLEX and is composed of an inkjet printing system that cuts down costs and time spent making OLEDs, resulting in the potential for mass production.

Time-to-Adoption: Four to Five Years

Telepresence

Telepresence is a form of remote conferencing in which the participants appear to be physically present in the conference space. Body language cues like eye contact are easily transmitted and interpreted because of the fidelity, size, and position of the images. Both 2D and 3D telepresence have been employed as a means of making it seem as though a user is in a location when they physically are not. This is a technique intended to make collaboration feel more seamless and replicate the benefits of face-to-face communication. Typically, 3D telepresence requires a specially configured space in which to capture a 360-degree image that can then be inserted into a virtual set and viewed from any angle, but high-definition displays, seamless integration with software and data presentation, and full-surround audio make even 2D telepresence a very immersive experience. Research and Markets predicts that by 2022 the Asia Pacific region will become the biggest market for the telepresence robot industry, and education will be a key application where growth is expected to happen over the forecasted period.³⁸

Relevance for Teaching, Learning, or Creative Inquiry

- 2D telepresence is often a consideration for distance learning, collaborative courses with students in other geographical areas, and guest lectures.
- The ability for physically disabled students to connect remotely from the comfort of their own homes with educators and courses allows them to receive equal learning opportunities as their peers.
- New high definition forms of telepresence are easily adapted to researching locations that human beings cannot physically reach or safely explore.

Telepresence in Practice

- Kubi is a telepresence robot from Revolve Robotics that is being used in schools that allows students using FaceTime to turn the display side-to-side and look around the room, helpful features for remote students: go.nmc.org/kubi.
- Using videoconference technology, the Science Department at Concordia International Shanghai hosted Shanghai's Particle Physics Masterclass, which allowed students from schools around the city to analyse real data from CERN's LHC particle accelerator and present their findings to physicists in the US: go.nmc.org/particle.
- The VGo telepresence robot is being used at the Nexus Academy of Columbus to facilitate a blended learning curriculum in which remote teachers interact with their students through a computer screen: go.nmc.org/vgobot.

For Further Reading

3 Districts Share their Telepresence Success Stories

go.nmc.org/threeshare

(*EdTech Magazine*, 8 January 2016.) Telepresence technology is being used to help students avoid getting behind in class during leaves of illness, to allow students to take courses offered elsewhere without leaving their own campus, and to reach remote students who would normally have to travel long distances to reach a school, especially during inclement weather conditions.

Using Video Conferencing Technology for Collaborative Learning

go.nmc.org/vidconf

(Peter Paccone, *Edutopia*, 4 June 2015.) The author gives advice on what technology to use for video conferencing and provides examples of how video conferencing has engaged his students with a variety of subjects by connecting them with experts, authors, students from other schools, and professionals.

Time-to-Adoption: Four to Five Years

Virtual Reality

Virtual reality (VR) refers to computer-generated environments that simulate the physical presence of people and/or objects and realistic sensory experiences. At a basic level, this technology can take the form of 3D images that users can interact with and manipulate via mouse and keyboard. More sophisticated applications of virtual reality allow users to authentically feel the objects in these displays through gesture-based and haptic devices, which provide tactile information through force feedback. While enabling people to explore new environments has compelling implications for learning, to date, virtual reality has been most prominently used for military training. Thanks to advances in graphics hardware, CAD software, and 3D displays, virtual reality is becoming mainstream, especially in the realm of video games. Oculus VR has developed Oculus Rift, a head-mounted display for gameplay to make the game environments and actions more lifelike. As both games and natural user interfaces are finding applications in classrooms, the addition of virtual reality can potentially make learning simulations more authentic for students.

Relevance for Teaching, Learning, or Creative Inquiry

- Many virtual reality technologies are already affordable and readily available; students have the opportunity to construct their own VR content as they go using mobile apps such as Cardboard.
- Through online platforms such as EON Reality, teachers can create their own virtual environments by uploading videos and instructional materials and combining them with 3D content.
- Virtual reality constructs can provide contextual, in situ learning experiences that foster exploration of real world data in virtual surroundings and simulations. For example, students can take field trips to ancient civilisations from their classrooms.

Virtual Reality in Practice

- At the Singapore American School, students are using zSpace, an immersive 3D technology that displays virtual-holographic images, to learn about science, physics, and engineering: go.nmc.org/vrspace.
- Students at the Singapore International School of Bangkok are using Google Cardboard to go on virtual reality expeditions and engage in authentic learning: go.nmc.org/gcvr.
- UWCSEA will be using Google Expeditions this year to enable virtual field trips and give students a deeper understanding of the world beyond the classroom: go.nmc.org/vrsea.

For Further Reading

Increasing Ecological Understanding with Virtual Worlds and Augmented Reality

go.nmc.org/ecovr

(Aaron Dubrow, Phys.org, 27 April 2015.) Researchers at the Harvard Graduate School of Education have created EcoMUVE, a curriculum that integrates the use of immersive virtual environments to teach middle school students about ecosystems, scientific inquiry, and complex causality.

Teaching with CAVE Virtual Reality Systems: Instructional Design Strategies that Promote Adequate Cognitive Load for Learners

go.nmc.org/cave

(Leah T. Ritz, Wyoming Scholars Repository, 2015.) An education researcher examines how the Cognitive Load theory can be applied to understand how the integration of virtual reality technology in pedagogy can alter cognitive behaviours to promote or impede deeper learning.

Methodology

The process used to research and create the *2016 NMC Technology Outlook for International Schools in Asia: A Horizon Project Regional Report* is very much rooted in the methods used throughout the NMC Horizon Project. All publications of the NMC Horizon Project are produced using a carefully constructed process that is informed by both primary and secondary research. Dozens of technologies, meaningful trends, and critical challenges are examined for possible inclusion in the report for each edition. Every report draws on the considerable expertise of an internationally renowned panel of experts that first considers a broad set of important developments in technology, challenges, and trends, and then examines each of them in progressively more detail, reducing the set until the final listing of trends, challenges, and important developments in educational technology is selected.

Much of the process takes place online, where it is captured and placed in the NMC Horizon Project wiki. This wiki, which has grown into a resource of hundreds of pages, is intended to be a completely transparent window onto the work of the project, and contains the entire record of the research for each of the various editions. The section of the wiki used for the *2016 NMC Technology Outlook for International Schools in Asia* can be found at isasia.wiki.nmc.org.

The procedures for selecting the topics that are in this report include a modified Delphi process now refined over years of producing the *NMC Horizon Report* series, and it began with the assembly of the expert panel. The panel as a whole was intended to represent a wide range of backgrounds and interests, yet with each member bringing a particularly relevant expertise. To date, more than 1,500 internationally recognised practitioners and thought leaders have participated in the NMC Horizon Project Expert Panels.

Once the expert panel for a particular edition is constituted, their work begins with a systematic review of the literature — press clippings, reports, essays, and other materials — that pertains to emerging technology. Panel members are provided with an extensive set of background materials when the project begins, and are then asked to comment on them, identify those that seem especially worthwhile, and add to the set. The group discusses existing applications of emerging technology and brainstorms new ones. A key criterion for the inclusion of a topic is the potential relevance of the topic to teaching, learning, or creative inquiry. A selection of dozens of relevant publications ensures that background resources stay current as the project progresses. They are used to inform the thinking of the participants throughout the process.

Following the review of the literature, the expert panel engages in the central focus of the research — the research questions that are at the core of the NMC Horizon Project. These questions are designed to elicit a comprehensive listing of technology developments, trends, and challenges from the panel:

1. *Which of these important developments in technology will be most important to international schools in Asia within the next five years?*
2. *What important developments in technology are missing from our list? Consider these related questions:*
 - a. *What would you list among the established technologies that some international schools in Asia and educational programmes are using today that arguably ALL international schools in Asia and educational programmes should be using broadly to support or enhance teaching, learning, or creative inquiry?*
 - b. *What developments in technology that have a solid user base in consumer, entertainment, or other industries should international schools in Asia and educational programmes be actively looking for ways to apply?*

- c. *What are the emerging technologies you see developing to the point that international schools in Asia and educational programmes should begin to take notice during the next four to five years?*
3. *What key trends do you expect to accelerate the uptake of emerging technology across international schools in Asia?*
4. *What do you see as the significant challenges impeding emerging technology uptake across international schools in Asia?*

One of the expert panel's most important tasks is to answer these questions as systematically and broadly as possible, so as to ensure that the range of relevant topics is considered. Once this work is done, a process that moves quickly over just a few days, the expert panel moves to a unique consensus-building process based on an iterative Delphi-based methodology.

The responses to the research questions are systematically ranked and placed into adoption horizons by each panel member using a multi-vote system that allows members to weight their selections. Each member is asked to also identify the timeframe during which they feel the technology would enter mainstream use — defined for the purpose of the project as about 20% of institutions adopting it within the period discussed. (This figure is based on the research of Geoffrey A. Moore and refers to the critical mass of adoptions needed for a technology to have a chance of entering broad use.) These rankings are compiled into a collective set of responses, and inevitably, the ones around which there is the most agreement are quickly apparent.

For additional detail on the project methodology or to review the instrumentation, the ranking, and the interim products behind the report, please visit the project wiki, which can be found at isasia.wiki.nmc.org.



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End Notes

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